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Path Dependency, Entrepreneurship, and Economic Resilience in Resource-Driven Economies. Lessons from the Newfoundland Offshore Oil Industry, Canada.

*'Creating resilient economies:
entrepreneurship, growth and development in uncertain times'*

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Abstract

Resource driven regional economies have experienced significant growth over the past decade due to increasing prices of raw materials such as oil and the need for customized and site-specific technologies to increase production and reduce risk. As a result, significant amounts of human and financial capital have built up in these regions. However, there are few examples of resource-dependent economies using these regional assets to successfully diversify away from their dependence on extractive industries, leading to profound declines as resource prices decline globally as they did in 2015. This paper examines the evolutionary lock-in and lock-out processes of resource economies and the potential of technology entrepreneurship to initiate path

creation in these regions. Based on interviews with entrepreneurs, investors, and policymakers in St. John's, Newfoundland, we explore the processes through which firms both inside and outside the resource industry are locked-in to existing economic trajectories and the ability of technology entrepreneurs to break out of these limitations and diversify into new industries and markets. We find that the relationships between the region's culture, its investment environment, and global changes in the oil and gas industry combine to create and reproduce industrial lock-in within the region. If long-term regional diversification and path creation appears to be the exception rather than the rule for resource-driven economies, entrepreneurs stand out as the central drivers of change shaping the path-enabling potential generated through resource booms.

1. Introduction

Economic resilience is a recurring theme in economies dominated by resource extraction activities. The literature has long emphasized strong path dependent processes that link to cyclical exogenous shocks associated with the fluctuation of commodity prices. Along with a greater mobility of workers, resource-driven regions tend to have more fragmented labour market structures, where the dominant resource sector provides high wage employment often contrasted by a large number of lower paid jobs in support industries (i.e. services). These characteristics are not without consequences for the long-term development trajectories of these regions.

Can diversification take place in these regions? In the developing world, corruption and poor infrastructure have limited the developmental potential of the wealth generated by resource extraction. However, in the Global North, city-regions such as Houston, Calgary, and Stavanger have been able to transition from low-value added extraction activities to higher-order economic activities such as technology development and corporate services. Entrepreneurs play a key role in transitioning the regional economy away from pure dependence on extraction towards other functions by acting as innovators and path creators. Extractive activities concentrate a large amount of human and financial capital in regions and create numerous opportunities for new ventures. Entrepreneurs can take advantage of these resources and opportunities and may expand into other resource markets abroad or into related or unrelated sectors. This decreases regions' dependence on local extractive opportunities, making it more resilient in the

face of sudden price shocks or other exogenous changes. However, extractive activities can also act as barriers to economic evolution. They create institutional structures that are difficult to break out of, lock-out other activities by driving up wage and housing prices, and can create cultures of dependence that discourage entrepreneurial risk-taking. Therefore, this is a tension between the lock-in effects of resource extraction and the opportunities it creates for path creation in the evolution of resource-driven regional economies towards more resilient and sustainable paths.

A former province in economic decline, Newfoundland and Labrador (NL) has experienced an unprecedented economic growth since the beginning of the offshore oil industry. Oil, gas and mining extraction and supporting activities generate revenues which form a significant part of Newfoundland economy. Most of this growth has happened in the city-region of St. John's, which is also the scene of soaring housing prices. A statistical analysis of the NL economy reveals that while its economy has enjoyed substantial growth up until the decline in energy prices in 2014, it still remains persistently dependent on resource extraction with limited diversification to either higher value added resource activities or into unrelated sectors.

Interviews with technology entrepreneurs inside and outside of the oil and gas industry reveal the underlying forces behind this lock-in, which include both a cultural resistance to risk, lack of spinouts from major firms, and a sparse investment environment.

2. Path Dependency and Economic Resilience in Resource-Driven Economies

2.1. From “Big Push” Theory to the Dutch Disease

There have been ongoing debates within academic and policy circles on the long-term regional development implications of resource extraction activities (Murphy, Shleifer, & Vishny, 1989; Rosenstein-Rodan, 1943, 1961; Sachs & Warner, 1995, 1999). From one perspective, natural resource endowments have been described as strategic assets that can spur long-term regional economic development and growth. One of the leading arguments for resource development is that extractive activities help develop and reinforce regional exports. 'Big Push' and economic base theories suggest that a strong regional export base induces local multiplier effects, offering new opportunities for economic development over time (North, 1956; Tiebout, 1956a, 1956b). Much in the same vein, resource development has been described as a necessary

initial step for regions to progress towards new phases of industrialization and more advanced service activities (Hoover & Fisher, 1949; Perloff, Dunn., Lampard, & Muth, 1960).

However, that resources represent key elements for regional prosperity is strongly challenged by growing evidence of limited development in resource-rich regions. What stands as the traditional perspective on resource economies is paradoxically that extractive industries pose limits to long-term growth and development. Economic historian Harold Innis was among the first to theorize that resource activities create the initial conditions for economic dependency and unequal development. In his Staples Theory, Innis (1930) emphasized that market forces and the cyclical nature of commodity prices play a critical role in shaping local systems of resource extraction. During resource price booms, a ‘cyclonic fury’ develops, diverting investment towards resource production and away from other sectors. When prices decline, that capital quickly flows to other regions, leaving scant new human or physical infrastructure behind that can help move the economy into new avenues for development. Staples Theory highlights that market failures in the form of structural rigidities are the likely outcome of disequilibrium generated by the mobilization and demobilization of resources through rapid periods of growth and decline—a characteristic of the commodity cycle.

In the wake of Innis, several other explanations have been proposed for the observed patterns of limited development in resource economies. Corden and Neary’s ‘Dutch Disease’ (1982) model explores the market mechanisms behind long-term resource dependency. Increases in revenue from the export of natural resources and the inflow of foreign investments frequently lead to a stronger currency relative to the importing nations, which affects the competitiveness of exports in other sectors (e.g. services and manufacturing). Economic booms also generate resource movement effects, where demand for labor shifts production toward the booming sector and away from lagging industries, leading to the deindustrialization of the latter over time. The impact can be quite strong. Beine, Bos, and Coulombe, (2012) estimate that between 33 and 39 percent of Canadian manufacturing employment was due to oil-related exchange rate development between 2002 and 2007. Extra revenues brought in by the resource boom further create a local spending effect that tends to increase the demand for labor in the non-tradable sectors (the service and public sectors), shifting labor away from the lagging sectors—a dynamic known as “indirect deindustrialization.”

Broader implications have also been described. Maloney et al. (2002) discuss a 'cultural Dutch disease:' a local rentier mentality where economic rents act as strong disincentives for local innovation, entrepreneurship, and institutional reforms. If returns are high enough in the resource sector, there is little need to invest in innovation, diversification, or new markets. From another perspective, limited development in resource economies has been associated with cycles of commodity production and stock collapses. An anticipated fall in resource stocks paradoxically creates a strong incentive for rapid extraction. A collapse in resource prices means other resources must be extracted to cover the economic loss of the previous dominant resource (Clapp, 1998). More generally, the dynamics found in resource regions describe asymmetric relationships with command and control centers where capital is being mobilized—a dynamic described in the critical perspectives of unequal development and the spatial divisions of labor (Liepietz, 1977; Massey, 1984).

2.2. Vulnerability and Resistance to Shocks

'Big push' or 'Dutch disease' dynamics describe two facets of the same reality. Uncertainty related to the volatile economic environment generated by shifting commodity prices can be understood as a critical force shaping the long-term developmental evolution of extractive economies. While resources represent strategic assets in growth periods, there is a high level of ambiguity on how this force plays in the long run, with regions facing increased risks of commodity-led downturns over time. In many ways, the dynamics found in resource regions are analogous to macroeconomic cycles of growth and recessions, although it may be argued that resource regions tend to suffer from more repeated and shorter exogenous shocks over time. This has significant implications for regional development trajectories. The recent financial crisis and subsequent period of instability have made scholars increasingly aware that the success of an economy extends beyond growth and relates to its long-term regional capacity to absorb, bounce back, or adapt to such changing economic conditions over time—a perspective best represented by the concept of 'regional economic resilience' (Martin & Sunley, 2014; Martin, 2012). Research suggests that economic crises and recessions generate differentiated regional impacts over time. Comparing a large sample of countries, Cerra and Saxena (2008) demonstrate that negative shocks can produce a sizeable permanent loss compared with pre-crisis trends, leading to diverging regional economies over time. Fingleton,

Garretsen, and Martin (2012) show that the impacts of recessionary shocks varied greatly among U.K. regions between 1971 and 2010, generating both permanent and temporal effects on employment growth. Looking at Denmark, Holm and Østergaard (2013) find that the recovery from the burst of the dot-com bubble has provoked disparities among regions.

However, despite the recognition of the importance of resilience, we still know little about the underlying mechanisms that make some regions able to better resist economic shocks than others. Briguglio et al. (2009) argue that a series of characteristics determine the risk of an economy being adversely affected by external shocks over time. Such risks may be seen as the outcome of the interplay between a region's initial vulnerability and its coping ability or resilience. This raises an important distinction between largely pre-determined factors and other characteristics that can be nurtured and changed over time. On one hand, vulnerability appears as an inherent and unescapable situation that determines a region's exposure to external shocks, such as its degree of economic openness, export concentration, or industrial structure. On the other hand, it is possible for regions to develop new coping abilities over time that will reduce the impact of a shock. Good political governance, social and entrepreneurial development, and other policies related to market efficiency and macroeconomic stability are further factors that contribute to local economic resilience. However, the degree to which regional policies are able to overcome deterministic processes found in resource-driven regions is not clear. If this dynamic appears to be central in explaining why certain resource-driven regional economies are able to more easily overcome economic downturns than others, it also suggests that this capacity is not a static process but one that develops incrementally over time.

2.3. Beyond Resistance to Shocks: Adaptability and Path Creation

While the capacity to resist economic shocks may be an important aspect in developing resilient resource-driven economies, there is growing evidence that this does not constitute a sufficient condition to fully detach from future negative impacts of the commodity cycle. Evolutionary concepts of 'path dependency' (Henning, Stam, & Wenting, 2013; Martin & Sunley, 2006; Martin, 2010) and 'lock-in' (Dobusch & Schüßler, 2013; Frenken & Boschma, 2007; Grabher, 1993; Hassink, 2007) are helpful in thinking about the long-term economic trajectories of cities and regions. As Martin (2010) describes, path dependency can be thought of as "the combination of historical contingency and the emergence of self-reinforcing effects,

[which] steers a technology, industry or regional economy along one ‘path’ rather than another” (p.3). This can take place along several lines, including functional, cognitive, and political lock-in (Grabher, 1993), as well as broader organizational, institutional, or technological dependencies ranging from the natural resource base to external ownership of specialized industrial production, sunk infrastructure costs, and inter-regional linkages.

Path dependency suggests that resilience goes beyond the ability to resist or recover from a shock. Martin and Sunley (2014) argue that responses to shocks occur as a process where the initial characteristics of a region impact a region's vulnerability, resistance, robustness, and recoverability over time. Therefore, resilience is not so much about avoid change but rather the ability of regional economies to re-orient or renew their economic bases over time in response to changes in the global economy. Most scholars agree that economic diversification is key in developing and strengthening the resilience of regions, since a diversity of activities will provide a variety of opportunities to adapt to a shock while sharing the risks among a larger group of industries.

However, developing new products or services is not an easily achievable objective in resource-driven economies. Evolutionary theory suggests that new activities in a region are likely to emerge from related local activities, whether in terms of products, skills, or technologies (Boschma, Minondo, & Navarro, 2013). Processes of diversification, either through ‘path creation’, ‘branching-out’, or ‘re-bundling’, emerge from current local industries and pre-existing regional capabilities (Bathelt et al., 2013; Frenken & Boschma, 2007; Neffke & Henning, 2013), conditions that are crucially lacking in resource-driven economies. While growing evidence shows that the presence of a variety of locally related activities (e.g. related variety) plays a critical role on the capacity for diversification, we know relatively little about the conditions which allow regional path creation and lock-in/lock-out processes to take place in resource-driven regional economies.

3. Entrepreneurship and Path Breaking in Resource Economies

Regions dominated by extractive industries are vulnerable to global cycles in resource prices, substitution from technological developments, or cheaper producers elsewhere. Traditional and more recent evolutionary theories suggest that resource-based economies represent a special kind of economy that is highly vulnerable to path dependency and lock-in, but

at the same time contain the potential for new path creation and long-term diversification. Resource economies depend on capital-intensive infrastructure that cannot be easily repurposed in a downturn and high levels of non-local ownership discourage local inter-firm cooperation (Isaksen, 2009). Formal institutions such as government subsidies for infrastructure development or educational programs designed to develop a specialized work force help to support and stabilize the resource industry but also create conditions for lock-in. Infrastructure often heavily depends on foreign direct investment and outside ownership by multinational resource firms with little value-added processing (such as refining) occurring locally. The global nature of the parent companies means that they often prefer to work with other global suppliers rather than smaller local firms. Resource extraction activity increases wages and housing costs, driving up expenses for firms outside the industry. This creates the potential for lock-in, where locally-owned firms are unable to participate in new activities or move up the value chain.

At the same time, boom cycles have the potential to create pools of financial and human capital that can be drawn on to diversify a region's economy away from simple extraction and towards more value-added activities such as processing, research, or business services. For example, some resource-driven economies like Aberdeen, Scotland or Houston, Texas, have been able to leverage early developments in oil extraction to become centers of resource technology development and business services. Scholars describe oil development in Norway and the North Sea as resource-based regional innovation systems (Cumbers, Mackinnon, & Chapman, 2003; Sæther, Isaksen, & Karlsen, 2011). Other cases such as mining activities in Australia have showed how knowledge spillover effects stimulated by resource development offer new opportunities for diversification, with the possibility of transitioning the economic base beyond the non-renewable extractive sector (Steen & Hansen, 2013; Steen & Karlsen, 2014; Ville & Wicken, 2013). These industries require highly educated workers to build, maintain, and finance the complex infrastructure necessary to extract oil in hostile environments. Periods of sustained booms in resource prices concentrate these people within the region, creating a population of skilled workers and potential investors that an entrepreneur can draw on. Large resource companies are increasingly externalizing non-core activities such as exploration, research and development, maintenance, and design functions in order to reduce their risk during cyclical downturns, which creates many opportunities for entrepreneurs (Aas, Buvik, & Cakic,

2008; Keogh, 1998). The combination of highly skilled workers, the availability of investment capital, and the presence of multiple unfilled market niches create the conditions for high levels of innovative and growth-oriented entrepreneurship in this industry (Cumbers, Mackinnon, & Chapman, 2003).

This gives regions experiencing a resource boom the potential to break out of existing economic trajectories and create new paths that are either associated with higher-end business service functions in the resource industry or that are totally unrelated to resource extraction. Entrepreneurs are key actors in this process (Staber, 2005; Stam, 2010). As Wolfe and Gertler (2006) argue, “entrepreneurs act as key agents who build on the existing base of institutional assets that provide the local antecedents” for path creation and economic growth (p. 251). This is due to the entrepreneurs’ unique ability to identify new opportunities in the market and to gather the resources, people, and networks they need to exploit it. Entrepreneurs can use local customers as a foundation for developing and selling advanced technologies before expanding to export these solutions to the global market. Similarly, the pools of human and financial capital within these regions can support innovations in new sectors, diversifying the economy away from its resource base and into related activities. Their flexibility in innovation and their ability to identify new opportunities help them induce more structural change than pre-existing firms (Neffke, Hartog, Boschma, & Henning, 2014). The potential for diversification through related activities (i.e. related variety) offers an opportunity for resource regions to use the human and financial capital that develop during periods of high resource demand as a platform for diversifying into non-resource industries and therefore establishing new economic trajectories for the region. For example, an entrepreneur might draw on local competencies in subsea remote sensing traditionally used in the offshore oil sector to develop specialized services for the construction of offshore wind farms. Even if local firms are locked out of participating in the larger resource industry, they still benefit from an increase in the availability of skilled workers, investors, and business infrastructure that the resource industry helps to create. Hence, resource booms or busts may be thought of as path-enabling or constraining environments with successive positive or negative impacts at both the firm and regional levels (Martin & Sunley, 2006; Martin, 2010).

Being locked-in to or locked-out of a resource-based economic activity can have both positive and negative implications for long-term economic activity (Simmie & Martin, 2010). Being locked into a resource-based path does not imply that there is little innovation or diversification. As argued above, entrepreneurs have the ability to move up the resource's supply chain to provide higher-value services to both local and global operators. Areas like Houston have been able to become centers of oil and gas corporate services and leading hubs of drilling, exploration, and processing innovation in addition to moving into unrelated sectors such as life sciences and digital technology. While such economies are still exposed to the cyclical nature of these resources, their related diversification has led to a situation of positive lock-in that contributes to long-term economic growth and competitive advantage.

Similarly, a region can still diversify and grow even if local firms are largely unable to participate in the resource supply chain. The capital and skilled workers attracted to the region by the resource development has the potential to spur unrelated diversification in other areas, decoupling the region from economic shocks related to boom and bust cycles. However, the most common outcome for resource regions is to be locked-in to resource production with little subsequent innovation and diversification, exposing the region to significant commodity price fluctuations with a long-term prospect of decline as the resource depletes. Similarly, the region will suffer even more if local firms are totally excluded from the resource production supply chain, with very little growth possible after the end of a resource boom: the region is trapped within a cyclical, price-taking sector and is unable to mobilize the human or financial capital necessary to escape. These paths are illustrated in Figures 1 and 2 and the effects of positive and negative lock-in/lock-out are summarized in Table 1.

[Figures 1 and 2 here]

[Table 1 here]

4. Path Creation and Path Dependency in Newfoundland & Labrador's Economy

4.1. Economic Decline and Growth

Recent developments in the economy of St. John's, Newfoundland economy highlight the tension between path creation and a path dependency in resource economies and the internal

processes that can drive or block the creation of new regional paths. The region has been a textbook example of Innis's Staples Thesis. St. John's has historically depended on the extraction and exportation of raw natural resources, beginning with cod in the early 17th century, and moving on to timber, nickel, and most recently, offshore oil and gas (Cadigan, 2009). Due to its peripheral location, low population, and lack of capital for infrastructure development, these resources have historically been exported with few localized value added activities, leaving the region vulnerable to cyclical fluctuations in the price of raw materials. A British colony and Dominion until joining Canada in 1948, Newfoundland has struggled with extreme poverty exacerbated by deep depressions in resource prices and the ultimate collapse of its cod fishery industry in 1992 (J. D. House, 1999).

The discovery of large petroleum reserves off the coast of Newfoundland in 1979 signaled a new potential for economic development. Underwater exploration and the construction and operation of offshore drilling and production rigs require large amounts of outside investment and generate significant local employment and economic spillover effects. The Hibernia, the world's largest offshore oil rig began operation in 1997, 315 kilometers offshore from St. John's. Subsequently, three other rigs have come online (Figure 3). This activity has had substantial economic impact. While St. John's unemployment rate has historically been higher than the Canadian average, since 2009 it has lower unemployment than the rest of Canada. Furthermore, the construction and operation of offshore drilling and production rigs require large amounts of outside investment and generate significant local employment and economic spillover effects. Similarly, the growth of the region's GDP has outpaced the rest of Canada's metropolitan areas over the past decade (Figure 4)—the sector accounting on average for 33% of the province over since 2007 (Statistics Canada, 2016).

[Figures 3 and 4 here]

The government of Newfoundland has fluctuated between an interventionist and laissez-faire approaches to the oil industry. Initially the provincial government tried to maximize the local employment impacts of the development through design and local supply requirements (Fusco, 2006). However, for subsequent development the government took a more hands off approach, allowing the design and construction of a majority of the infrastructure to be carried out elsewhere (J.D. House, 2003). Agreements between the province and the consortiums

developing the oil field have led to the establishment of the Petroleum Research Board of Newfoundland and Labrador, which mandates that a percentage of the revenues from oil production be reinvested in local research and development for the oil industry.

Even before the rise of St. John's oil sector there have been attempts to spur the creation of a maritime technology cluster. Both federal and provincial authorities have invested heavily in ocean engineering research at the Memorial University of Newfoundland, a National Research Centre laboratory, as well as by creating the Centre for Cold Ocean Resource Engineering a public-private research and development corporation established in 1975 to develop technologies that can address specific challenges found in the oceans surrounding Newfoundland and Labrador, such as sea ice, icebergs, and frequent storms. However, there has only been limited success in creating a maritime cluster: while there are more than 50 firms involved with maritime technology, there is limited interaction and knowledge spillovers between them (Doloreux & Shearmur, 2009). This is in part due to the lack of a local market for maritime technologies outside of the oil sector.

Policy development over the past two decades suggest that provincial and federal programs are simultaneous focused to maximizing the economic benefits of the oil and gas industry while also attempting to diversify the economy away from complete dependence on this industry. Agencies such as the Atlantic Canada Opportunity Administration provide substantial grants for research and development to develop export markets and local universities and colleges are expanding their capacities to produce more trained workers for the oil and gas industry. Provincial law has established requirements that offshore produces fund R&D projects carried out by local firms in the hopes that this will improve the innovative capacity of startups and create the potential for knowledge spillovers.

4.2. Exposure to Shocks and Vulnerability

The substantial GDP growth of the past decade does not fully reflect broader changes taking place in Newfoundland and Labrador's economy. Important shifts in market structures suggest that the province has become increasingly vulnerable to exogenous shocks over the past fifteen years. One aspect of this vulnerability relates to the level of economic openness, measured as the ratio of international trade to GDP, which is an indicator of the degree of exposure of an economy to international demand and supply. While often seen as a source of

strength and market expansion, exposure is also argued to generate new vulnerabilities, since it necessarily entails that a larger share of a local economy depends on both inputs and final demand on which it has no direct control (Briguglio et al., 2009). This is particularly problematic for smaller economies where the size of the local market remains insufficient in scale for developing local substitutes at times of crisis—a condition which applies to the NL economy.

There is clear evidence that the rapid development of the Newfoundland and Labrador offshore Oil & Gas industry has resulted in an increased exposure to exogenous shocks. Between 1990 and 2014, the province has seen international trade accounting for less than 8% of GDP to more than 54%—the highest openness level and relative growth among Canadian provinces. In contrast, the Canadian economy has seen a much more limited evolution, passing from 11% to 36% over the same period (Figure 5). One implicit consequence of this shift is that a larger share of the province's economy is now exposed to the condition of international market on which it has no direct control.

Another interpretation is that this rapid increase in economic openness describes the successful internationalization of firms in the province, with diversified exports across sectors. However, the data provides strong evidence that exportations are concentrated in only a few industries (Figure 5). The distribution of exports across the top twenty-five industries (2007 CAD), represented through the Herfindahl-Hirschman index (HHI)¹, shows a very high level of concentration, passing 0.2 in 2000 to more than 0.25 in 2014². In comparison, Canadian exports have been much more diversified, with a HHI of 0.04 and 0.06 for the same years, despite a significant rise in Albertan oil exports over the period. To give an order of magnitude, the top two industries in Newfoundland & Labrador (Oil and Gas Extraction; Petroleum Refineries) represented 75% of all exports in 2014, while in Canada, the top two industries (Oil and Gas Extraction; Automobile Manufacturing) accounted for less than 31%. This level of concentration of exports in the oil industry is particularly well captured by the evolution of the HHI, which appears to fluctuate in relation to oil prices between 2000 and 2014 (Figure 6). These changes not only imply that local firms and entrepreneurs may be affected at times of a downturn, but that government revenues and local input-output structures may be vulnerable to future oil shocks.

¹ Equations provided in Appendix.

² A value above 0.2 is usually recognized as describing a high level of concentration.

[Figures 5 and 6 here]

Employment concentration across sectors provides another perspective on economic vulnerability. Proportional employment distributions can be seen as a mitigating factor against job loss, since there are less chances that a large number of employees will become unemployed in case of an industry-specific shock. Distributions for Newfoundland and Labrador, however, show an important concentration, with an Herfindahl index well above the Canadian average (Figure 7). While Canadian employment has become more evenly distributed since the mid '80s, NL employment concentrations have been fluctuating around a median high position, resulting in little absolute changes between 1976 and 2015. These trends provide further indication that the province has overall increase its exposure and vulnerability to potential future employment related exogenous shocks.

[Figure 7 here]

4.3. Reactions to Shocks and Diversification

That structural shifts result in an increased vulnerability of the NL economy does not provide the full answer as to how the region is over time adapting and changing at various stages of the commodity cycle. Despite lock-in dynamics taking place, the positive shock of the oil boom between 2000 and 2014 has been a powerful force, with the possibility to generate early stage conditions for long-term diversification and regional lock-out. The large amounts of capital and new investments that fuelled the NL economic boom means that new pools of financial and human resources have become available for developing new and more value-added activities. Employment dynamics provide evidence that the oil boom has indeed acted as a catalyst for the economic restructuring of the NL economy (Figure 8). From a low point in the post-shock impact of the cod moratorium in 1992, employment in the goods producing sector has started to increase at a rapid pace, increasing above its 1976 value passed the 2008 crisis. Service jobs have also increased, although more steadily over the period.

[Figure 8 around here]

Employment growth dynamics in specific industries provides further details on the economic restructuring that has taken place in the NL economy between 1976 and 2015 (Figure 9). The fisheries to oil transition, as seen by the steady job decline in extraction industries

followed by a renewed growth emerging in the early 2000s, appears as the dominant feature of this transition. One aspect related to the impacts of this transition on local activities derived from resource extraction. On the one hand, the emerging oil industry has not been able to provide a substitute for regenerating the pre-1990s manufacturing jobs—mainly first transformations in the fisheries—which are markedly declining since. On the other hand, there are clear trends that the oil boom has had an important impact on employment creation in advanced and knowledge-intensive services (KIBS) as well as business, building, and other support services. Although below the Canadian average, the post 1995 growth in both sectors has been closing the gap, with employment creation above the Canadian average in several cases. Technical, professional, and scientific services related to offshore activities suggest that there have been significant opportunities for technological diversification and entrepreneurship.

[Figure 9 here]

5. Entrepreneurship and the Challenges of Path Creation in Resource-Driven Regional Economies

The statistical evidence suggests that Newfoundland's economy is locked-in to resource-driven economic trajectories. But these data by themselves provide limited insight into the processes through which this lock-in occurs. To better understand the lock-in process in Newfoundland, we conducted interviews with technology entrepreneurs in St. John's, Newfoundland's capital and dominant urban area. Offshore oil and gas activity has created numerous opportunities for entrepreneurs ranging from supplying the offshore rigs with basic services to technological developments to aid offshore oil exploration and production. This creates the potential for entrepreneurs to catalyze new economic trajectories, for instance by using technology used in offshore rig construction for offshore wind development. As argued above, resource booms attract the human and financial capital to a region that entrepreneurs need to innovate and open new markets. However, it also creates barriers to any kind of entrepreneurial diversification of the broader economy. In total, 32 interviews were carried out with technology entrepreneurs, local investors and economic development officials in St. John's (see Table 2). The interviews focused on how entrepreneurs developed new products and entered new markets and the barriers and challenges they face in Newfoundland.

[Table 2 Around here]

The interviews show three interlocking forces underlying the region's continued economic lock-in. These are *changes in the offshore industry* which have progressively shut out new firms from participating in the resource sector, *cultural lock-in* related to Newfoundland's extensive history of poverty that discourages entrepreneurial risk-taking and an *under-developed investment environment* that make it difficult for entrepreneurs to get the capital and assistance they need to achieve substantial growth. While there is substantial technology entrepreneurship activity in the region, these barriers restrict the growth of new ventures and limit their ability to spur long-term diversification of the economy away from extraction activities with little local value-added activities.

5.1. Industry Structure

The entry of major oil and gas operators in the 1990s were seen as a key source of entrepreneurial opportunities. Similar regions like Aberdeen, Scotland have seen high rates of successful entrepreneurs who were able to build major international oil and gas service firms by first starting to serve the local producers before expanding internationally (Cumbers, MacKinnon, & McMaster, 2003) . By serving the local market, new firms are able to build up their expertise, capabilities, and their connections within a very tight-knit industry that depends on reputation and legitimacy. However, interviews with entrepreneurs in the oil and gas space and other experts suggests that entering this market has been more difficult than anticipated. the industry is now far more difficult for entrepreneurs to enter than it was in the past. The industry has undergone considerable consolidation and global oil producers such as Exxon prefer to work with other global oil services companies such as Halliburton or Schlumberger who can provide standardized technological services and supplies to all their offshore facilities around the world (Davis, 2006). The major operators prefer to work with large global suppliers rather than smaller startups who lack an established track record. In the words of a local investor, while the industry has created numerous opportunities, "...those sorts of opportunities are taken up by mostly industry players and not people like us" (SJ23). There is now less opportunity for entrepreneurs to serve the local industry, even for low-value-added activities like catering or maintenance.

Entrepreneurs have had some success at entering the oil and gas supply chain has been providing solutions that address conditions specific to the Newfoundland offshore industry, iceberg detection and avoidance. However, focusing on this area reduces their ability to enter

other markets and grow beyond local needs. Currently, Newfoundland is the only offshore oil production zone that requires iceberg detection equipment. Because there are only four production rigs in Newfoundland (compared to over 700 structures in the Gulf of Mexico) there is a limited demand for services, making it difficult for entrepreneurial firms to use their local operations to finance the intensive R&D and marketing necessary for entering the global oil services value chain. Beyond this, as a local economic development official explained: "it turned out the ice wasn't anywhere near as much of an issue as they thought it was going to be...[the rig operators] found they could use a lot of off the shelf kit, went back to Houston, and brought it all up here" (SJ07).

As a result, the majority of interviewed entrepreneurs who were in the oil and gas sector (5 of 8) saw themselves specifically serving the local market with few plans for growth outside the local market in the near term. This reinforces existing paths related to the oil and gas sector. While the expansion of oil exploration into the arctic may increase the demand for iceberg detection, currently the technology is currently only needed in Newfoundland. As a result, new firms in this sector have a limited ability to break out of the local market and diversify to meet global needs. As one entrepreneur in this sector said: "I think it's difficult to walk into a different area where you're not from and get the same street cred that we have right here. By the same token, we're only going to be able to leverage off ...our knowledge and our industry contacts to a certain level before that taps out" (SJ22).

5.2 Cultural Lock-in

The second barrier to new path creation is the region's long-standing cultural attitudes towards risk and entrepreneurship. There are very few examples of experienced oil and gas managers or engineers leaving the stable employment of a major operator and creating their own spinout firms. Other regions such as Aberdeen or Houston have seen high rates of spinoff creation as a key engine of economic development. However, in St. John's, only three of the twenty entrepreneurs interviewed had a background in the oil and gas sector. Many economic development officials suggested that few if any senior managers or engineers in the offshore industry had any interest in leaving the stable employment and high pay of the major operators for the risks of developing a new startup. They "like the comfort of a nine to five job for the government or for Exxon Mobil" and see no reason to take on the risks of entrepreneurship

(SJ1). Some interviewees suggested that the high wages in the industry and lack of a pre-existing entrepreneurial culture in the region decrease the economic and social incentives for creating a new startup. An economic development officer suggested that it would be “highly unusual for someone to say ‘well I’m going to quit my \$200,000 a year job’ to start a new venture” (SJ4).

There is clear evidence from the interviews that local culture acts as a barrier to entrepreneurship for those with established careers in the oil and gas industry—what can be described as cultural lock-in. Numerous interviewees in both the local government and industry associations commented on the lack of an entrepreneurial and risk-taking culture in the community. The traumatic impact of the collapse of the local fishing industry in the 1990s, in which 40% of the workforce—including a large contingent of self-employed 'entrepreneurial' fishermen—lost their employment, has also contributed to a risk-averse culture that discourages highly paid workers from leaving stable employment for the extreme risks of entrepreneurship. The director of a local angel investment syndicate commented that “there’s a risk aversion here” (SJ24) and a former technology transfer officer at MUN suggested that “no one has any tolerance for failure at all in Newfoundland” (SJ19). This is exacerbated by the lack of a history of entrepreneurial success stories in the region to encourage new generations of entrepreneurs. The relative lack of social legitimacy of entrepreneurship as part of a normal career path and the lack of successful entrepreneurial role models in this sector reduces the supply of potential entrepreneurs in this sector. This is evidenced by the lack of serial entrepreneurs in the region. Only four of the twenty entrepreneurs interviewed had previously started and exited previous startups. As a result of this cultural lock-in, there is a lack of entrepreneurial skill and experience both inside and outside the oil and gas industry.

5.3. Sparse Investment Environment

Many interviewees cited the lack of investment capital in the region as a major barrier to any kind of entrepreneurial expansion or diversification efforts. Without investment, it is difficult for startup firms to finance the type of R&D activity or market development plans required to avoid being locked in to their current markets and territories. Interviews with entrepreneurs, economic development officers, and investors confirmed that there are only two technology angel investors in the region. Both investors commented in interviews that they have experienced difficulties recruiting other local business people in the region to invest in technology startups

instead of more traditional and safer investments such as real estate. A city economic development official summed up the situation simply: “The city does not do any kind of angel investment and I don’t even foresee that ever occurring” (SJ12). Similarly, the leader of a local investment group asked “how do you get [these investors] to move beyond bricks and mortar?” (SJ24). While many potential investors are happy to hear pitches from entrepreneurs, few outside of the two leading angels have invested substantial amounts without first waiting to see if the region’s two lead investors are also interested.

This creates several challenges for technology entrepreneurs in St. John’s looking to diversify their products or markets. Firms require outside investment to introduce new products and undertake the travel necessary to develop partnerships and sales in other regions or industries. Without investment, firms need to rely on internal revenues to fund both their day-to-day operations as well as their long-term product development plans. But beyond simply supplying financial capital, early-stage investors are important sources of advice, mentorship, and industry contacts. Without this expertise a large investment can hurt a startup by allowing them to grow too quickly without making the strategic and operational changes that this growth requires. Because there have been so few entrepreneurial exits, there is not a pool of successful entrepreneurs who can act as advisers and investors in new startups. An entrepreneur in the green energy sector commented: “investors here are, you know, your local brick-and-mortar investors who’ve might have made a lot of their capital through running a grocery store or construction company [but] there’s definitely a lack of understanding of high-tech” (SJ17).

The underdeveloped angel investment community reflects absence of a local entrepreneurial culture that legitimizes the risk of angel investing. Angel investors in St. John’s are motivated as much by a desire to give back to their community as much as they are interested in the potential profits from their investment. One angel investor commented, “I’m not trying to be a professional investor here. I don’t have the skills or the money or the time for it, so I’m, you know, part of the motivation is my wife and I want to do a good thing here, and we can’t do good for the entire world; we’ve got to pick a spot, so Newfoundland is our spot” (SJ23). While in one sense this is a positive element that demonstrates the importance many investors attach to supporting their local community, it depends on the goodwill of investors and is ultimately not

sustainable in the face of low returns. A local culture that supports and legitimizes entrepreneurial risk-taking helps justify the decision to invest and support an entrepreneurial venture over what may be a more prudent investment decision. While these two major investors are trying to encourage others in the business community to act as angel investors they have been unsuccessful thus far. The lack of such a culture in St. John's has made it more difficult to attract high-net-worth individuals in St. John's into its small investment community.

6. Conclusion

The experience of Newfoundland's economy is an example of how difficult it is for regions to embark on new economic paths. The province's economy has undergone profound changes in the past two decades: the discovery of offshore oil and gas reserves has resulted in billions of dollars of investment in the region that have helped to attract skilled workers and created numerous new opportunities in the economy. Until the sudden decrease in oil prices in 2015 the province had emerged from decades of population decline and economic shrinkage to become a centre of development in the Canadian economy. However, there are still substantial barriers to creating new economic paths that either build on the extractive industries (by developing new technology and selling it to new markets) or in completely unrelated areas. The interviews with entrepreneurs suggest that the region's existing economic trajectories are difficult to break out of due to both the changing structure of the global energy industry as well as the cultural lock-in that discourages risk taking, investment, and innovation. As a result, Newfoundland's economy has remained extremely vulnerable to external shocks despite its substantial economic growth. The region's entrepreneurs are locked out of both participating in the oil and gas industry — which would help spur higher-value added exports that would detach the region from depending entirely on local production levels — as well as in unrelated markets that would help reduce dependence on global energy prices. As a result, the province's economy suffered a substantial contraction in 2015-2016 as a result of falling oil prices, leading to a downgrading of its credit and drastic cuts in public and private investment and spending.

This suggests that resiliency and new path creation do not come from economic growth alone. Rather, it requires a more fundamental change in the underlying social structure and networks within the region to empower entrepreneurs and other actors to explore new markets,

technologies, and organizational forms. Resources attracted to the region during a boom time will quickly leave it when the immediate opportunity evaporates, requiring that the region's political and business community help create their own unique assemblage of resources and competencies that can power more sustainable economic development.

Appendix

The Herfindahl index for a given region k , H_k , defines the relative specialization of the region. Formally, the Herfindahl index is simply defined as the sum of the squared proportion (in percentage) of jobs (or establishments), p_{sk} , (equation 1) calculated using the economic activities in economic sector s , x_{sk} , over the total economic activity in the region, $x_{\cdot k}$ (equations 2 and 3).

$$H_k = \sum_{s=1}^S p_{sk}^2 \quad (1)$$

Where

$$p_{sk} = \frac{x_{sk}}{x_{\cdot k}} \quad (2)$$

And

$$x_{\cdot k} = \sum_{s=1}^S x_{sk} \quad (3)$$

To simplify, it can be postulated that $x_{sk} = e_{sk}$ if one uses the total employment, or $x_{sk} = f_{sk}$ if one uses the number of firms (establishments), where e_{sk} is the total employment of the region k in the economic productive sectors s and f_{sk} is the total number of establishments in region k , within the economic productive sectors s . In all cases, the sum of the individual proportions, p_{sk} , for all economic sectors in a given region k , is equal to 1 (equation 4).

$$\sum_{s=1}^S p_{sk} = 1 \quad (4)$$

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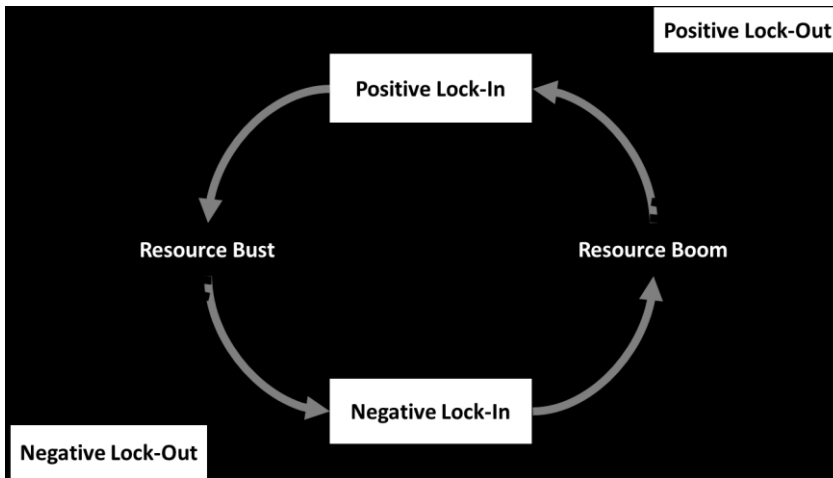
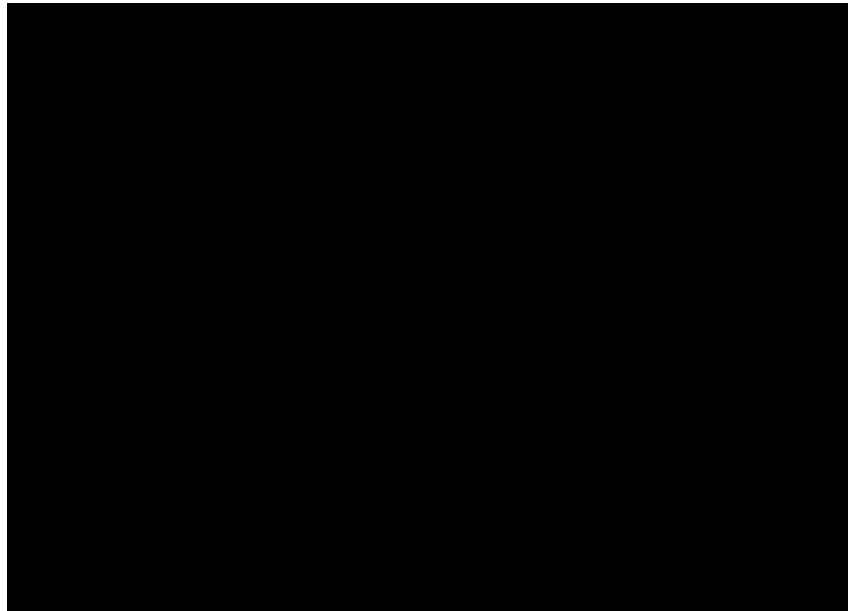


Figure 1: Theorizing the commodity cycle as a path enabling or constraining environment



- A** – Positive lock-out (unrelated and related diversification)
- B** – Positive lock-in (related diversification)
- C** – Negative lock-in (stagnant economic structure; cyclic diversification)
- D** – Negative lock-out (de-industrialization; economic decline)

Figure 2: Stylized evolutionary paths of resource regions*

*Adapted from Martin and Sunley (2006)

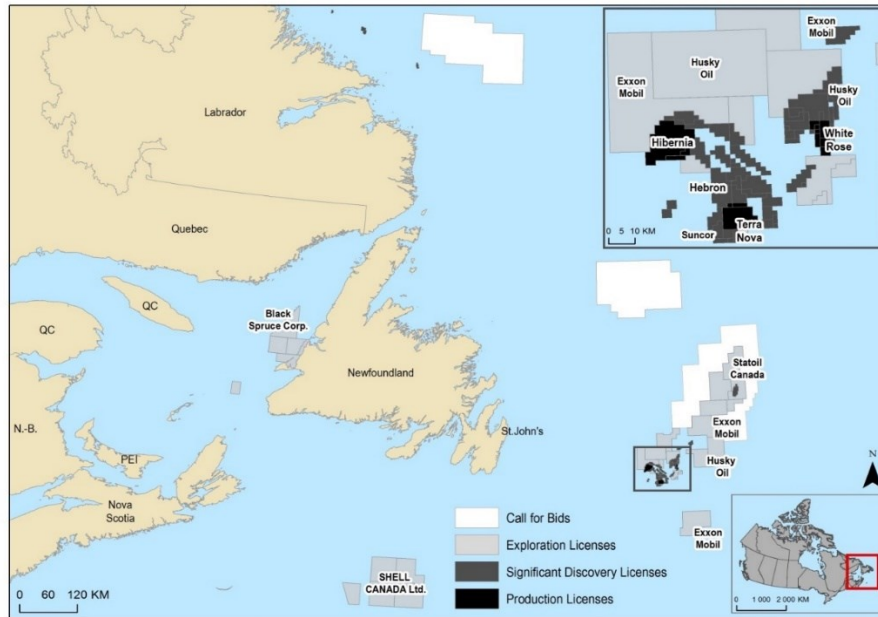


Figure 3: Newfoundland & Labrador offshore exploration and production licenses, 2015
 Source: Canada-Newfoundland and Labrador Oil and Petroleum Board (CNLOPB), 2015.

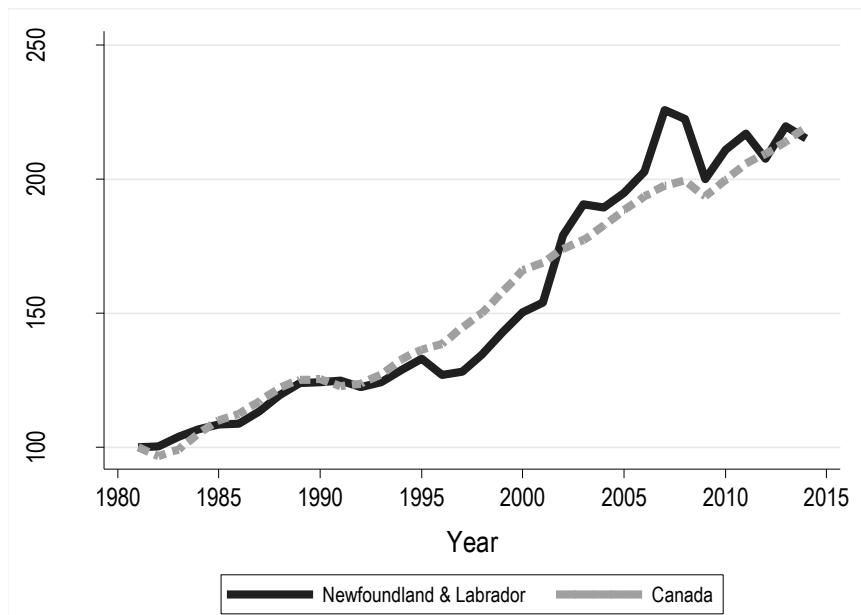


Figure 4: GDP Growth in Newfoundland & Labrador and Canada, 1980-2015
Source: Statistics Canada, 2016a.

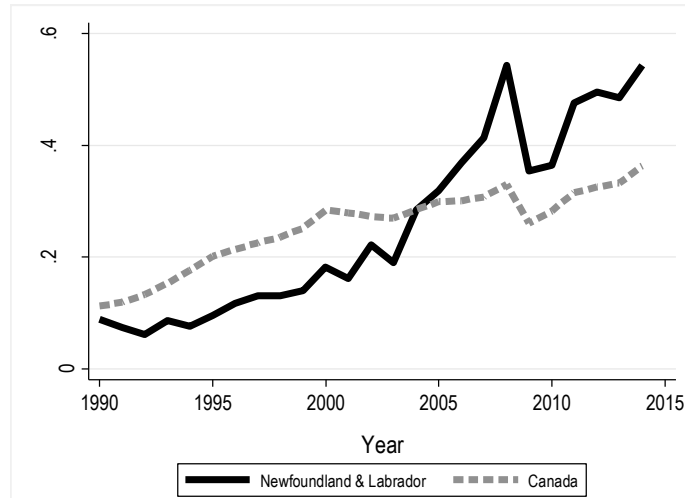


Figure 5: Economic openness in Newfoundland & Labrador and Canada, 1990-2015
Source: Statistics Canada, 2016a, 2016b.

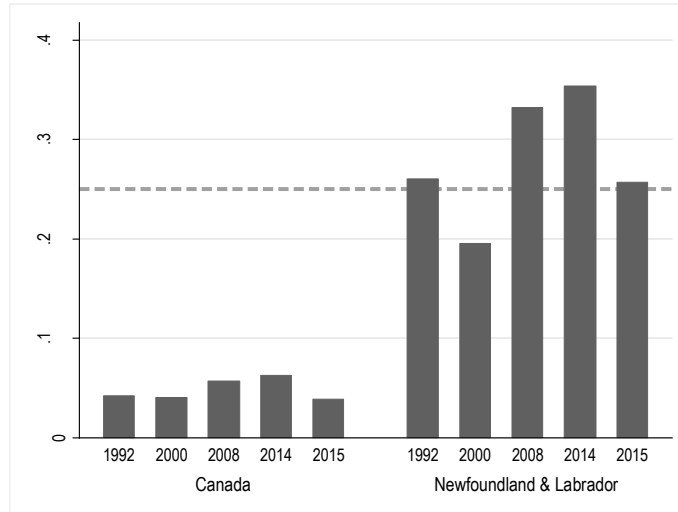


Figure 6: Export concentration within top 25 industries, Newfoundland & Labrador and Canada, 1992-2015

Source: Industry Canada, 2016.

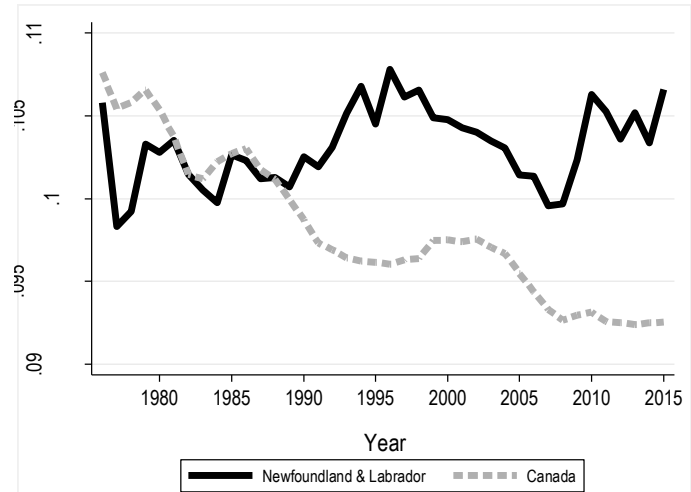


Figure 7: Industrial Concentration in Newfoundland & Labrador (employment), 1976-2015
Source: Statistics Canada, 2016c.

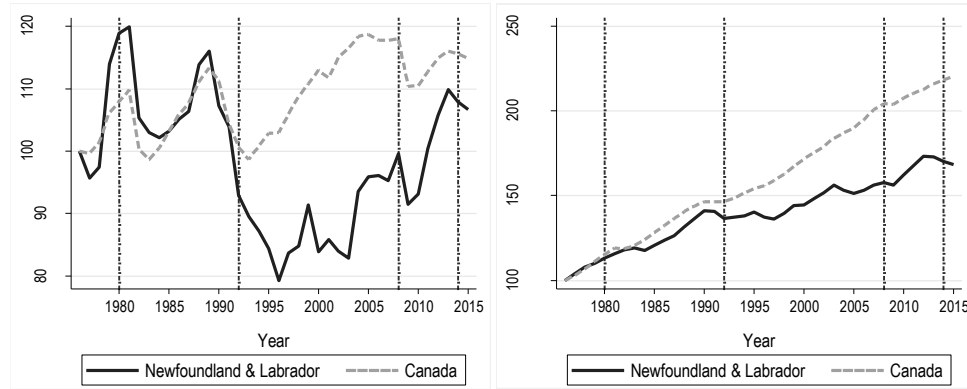


Figure 8: Employment Growth, Goods / Services, Newfoundland & Labrador, 1976-2015
 Source: Statistics Canada. 2016c.

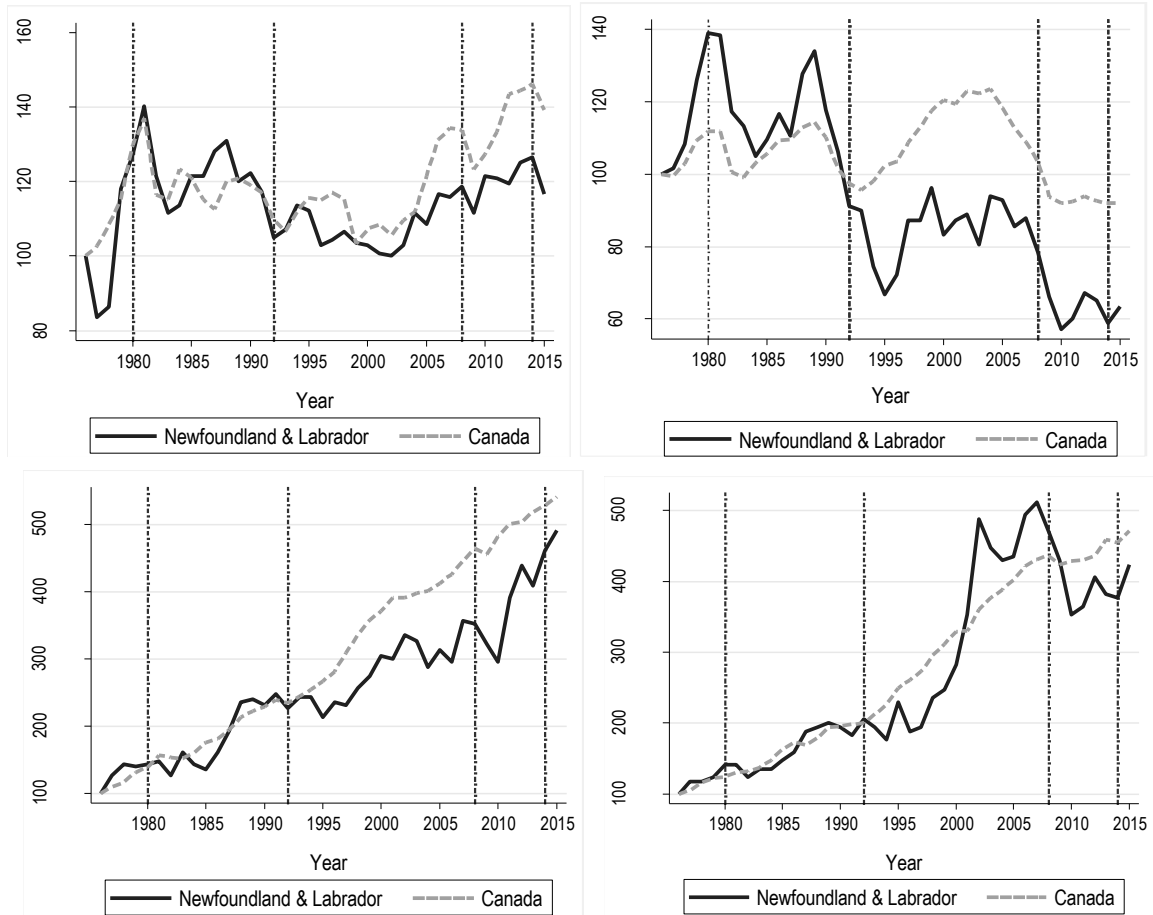


Figure 9: Employment Growth, Selected Industries, Newfoundland & Labrador, 1976-2015. Source: Statistics Canada. 2016c.

Table 1: Positive and negative lock-in/lock-out processes in resource economies

| | Regional economic lock-in | Regional economic lock-out (path creation) |
|-----------------|---|---|
| Positive | <ul style="list-style-type: none"> – Related diversification: creation and attraction of new technologies and skills within the dominant resource industry. – Value-chain reinforcement: fast growth and transaction-specific investments lock firms into a given exchange relation within the resource value chain. – Strengthening of institutional and political tissue secures investments in the dominant sector. – Standardization in adoption of local technologies secure local market for that technology. | <ul style="list-style-type: none"> – Related and unrelated diversification: creation and attraction of new skills and technologies outside the dominant resource industry. – Value chain upgrading: greater cooperation and interactions allow firms to diversify their services and products and re-position in the value chain across sectors. – Sustained growth in resource activities attracts firms and investments into other local activities, which contributes to the development of new institutional and political tissue outside the dominant sector. – Technologies developed for the dominant sectors are adapted and used in other sectors. |
| Negative | <ul style="list-style-type: none"> – Lack of local investments and growth opportunities in other sectors creates a barrier for diversification. – Captive value-chain structures make local firms more vulnerable to economic downturn. – Strong social and institutional tissue hinders the sharing of new ideas, learning, and innovation over time. – Technological regimes hamper the development and adoption of novel systems and technologies over time. | <ul style="list-style-type: none"> – Declining diversification: collapse of the dominant sector leads to de-industrialization and out-migration of skills. – Exit of the resource value-chain: lack of growth in resource industries lowers the opportunity costs for entering new value-chains. – Dissolution of the dominant social and institutional tissue creates a weak base for new investments, while creating new opportunities for new ideas and innovation over time. – Unused capacity of previous specialized resource technological systems creates long-term financial burdens while offering new opportunities for adaptation into other sectors. |

Table 2: Interviews in St. John's, Newfoundland

| | Entrepreneurs | Economic Development Officials | Investors | Total |
|------------|---------------|--------------------------------------|-----------|-------|
| Interviews | 20 | 8 | 4 | 32 |

Source: Interviews